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New records of *Acarospora* and *Psora* from China

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Abstract—*Acarospora impressula, A. umbilicata, Psora gresinonis, and P. himalayana* are reported for the first time from China and *Psora decipiens* for the first time from Qinghai Province. Descriptions, illustrations, and distributions are given for each species.

Keywords —*Acarosporaceae,* East Asia, lichenized fungi, *Psoraceae,* taxonomy

Introduction

Acarospora (*Acarosporaceae, Acarosporales*) was established by Massalongo (1852). The genus is characterized mainly by crustose (often distinctly areolate or subsquamulose) thalli, 16–100+-spored asci with non-amyloid apical domes, and hymenium typically over 100 µm thick (Knudsen 2007, Fletcher & al. 2009). The genus contains about 200 species (Lücking & al. 2016), usually on siliceous rocks, rarely on calcareous rocks, wood, and soil, often in arid habitats (Knudsen 2007, Fletcher & al. 2009, Øvstedal & al. 2018). In China, 35 species have been reported (Dongling & al. 2017, Knudsen 2007, Wei 1991, Nurtai & al. 2019).

Psora (*Psoraceae, Lecanorales*) comprises 30 species growing on soil and rock, mainly in arid areas, in arctic to subtropical regions (Timdal 2002). The genus is characterized mainly by squamulose thalli, a hypothecium containing calcium oxalate crystals, porpidia-type asci, laminal pycnidia, and acrogenous bacilliform pycnoconidia. In China, 11 species have been reported (Abbas 1998, Mamut & Abbas 2016, Wei 1991).

# Chun-Xiao Wang & Chuan-Feng Zheng contributed equally to this manuscript.

In this paper we provide valuable information on *Acarospora* and *Psora* in China in preparation for a revised edition of Wei's (1991) book, AN ENUMERATION OF LICHENS IN CHINA. Here, we identify four species new to the country—*Acarospora impressula*, *A. umbilicata*, *Psora gresinonis*, *P. himalayana*—and report *P. decipiens* for the first time from Qinghai Province.

Materials & methods

The specimens studied were collected in Inner Mongolia Autonomous Region (Neimenggu) and Qinghai Province, China, and are preserved in Lichen Section of the Botanical Herbarium, Shandong Normal University, Jinan, China (SDNU). The specimens were examined morphologically under a COIC XTL7045B2 stereomicroscope and Olympus CX41 polarizing microscope. Thallus and medulla were tested for identification with K (10% potassium hydroxide aqueous solution), C (saturated aqueous sodium hypochlorite solution), and I (Lugol's iodine). The lichen substances were identified using standardized thin layer chromatography techniques (TLC) with system C (Orange & al. 2001). The lichens were photographed using an Olympus DP72 camera attached to Olympus SZX16 and BX61 microscopes.

Taxonomy

Acarospora impressula Th. Fr., Lich. Scand. 1: 214 (1871) FIG. 1

THALLUS areolate, rugulose, with cracks between areoles, 0.3–0.7 mm wide, 0.3–0.5 mm high. Upper surface brown, slightly white pruinose. Epinecral layer 20 μm. Cortex 22.5–37.5 μm thick. Algal layer uneven, interrupted by hyphal bundles, ≤175 μm thick, algal cells 10–17.5 μm in diam. Medulla white, plectenchymatous, ≤300 μm thick. APOTHECIA 0.36–0.41 mm wide, disc dark brown. Exciple hyaline, distinct, 2.5–125 μm wide. Epihymenium light yellow, 12.5–17.5 μm tall. Hymenium hyaline, 45–75 μm tall; paraphyses hyaline, simple or slightly branched, conglutinate. Asci hyaline, 62.5–75 × 15–17.5 μm, 100–200-spored; ascospores simple, ellipsoid, 2–3 × 5–6 μm. Subhymenium hyaline, 12.5–52.5 μm tall. Hypothecium hyaline, indistinct. Algal layer uneven, interrupted by hyphal bundles, ≤150 μm thick, algal cells 7.5–15 μm in diam. Medulla containing many crystals.

CHEMISTRY—Thallus K–, C–, KC–, hymenium I+ blue; no secondary metabolites detected by TLC.

SPECIMEN EXAMINED—CHINA. NEIMENGGU, Hu He Ba Shi Ge, alt. 1600 m, 16 Aug. 2011, D.B. Tong 20123540 (SDNU).

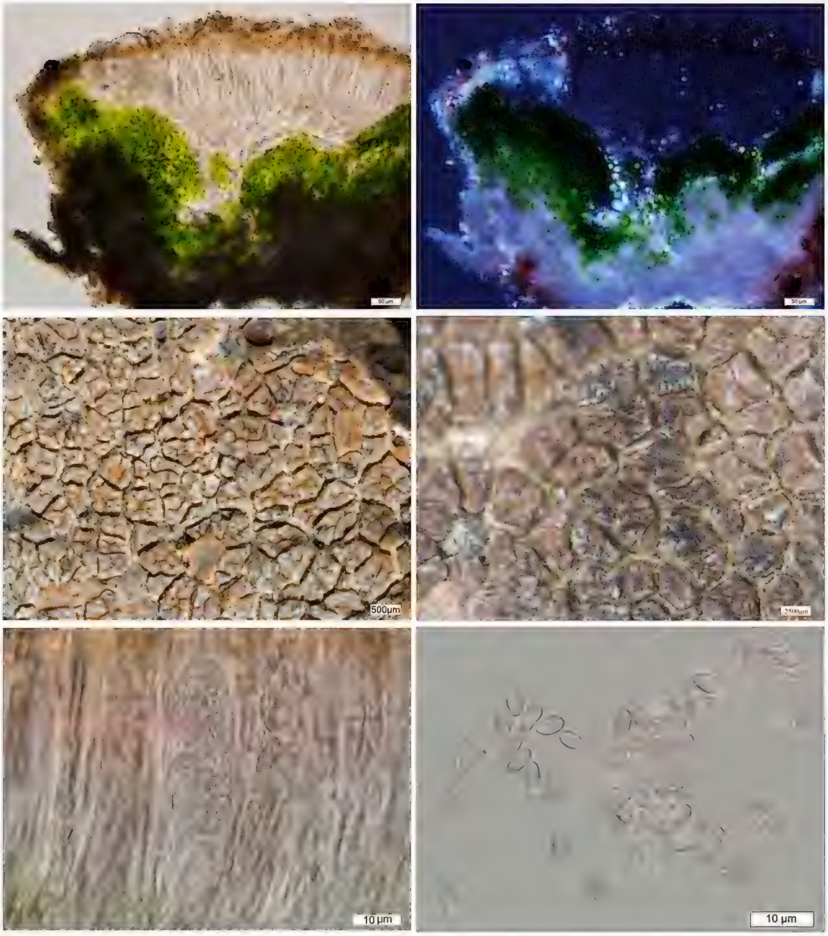

Fig. 1. ***Acarospora impressula*** (Tong 20123540, SDNU). A, B. Apothecia section; C. Thallus and apothecia; D. Apothecia; E. Asci; F. Ellipsoid ascospores.

Ecology & distribution—On siliceous or calcareous rock. Europe, Asia, North Africa, Greenland, North America, Australia (Temina & al. 2005, Øvstedal & Gremmen 2014). New to China.

Comments—Through studying *Acarospora* from China, it was found that *A. brevilobata* H. Magn. and *A. gobiensis* H. Magn. have similar ascospores to *A. impressula* but differ in their thallus, which is circular in *A. brevilobata* and yellow in *A. gobiensis* (Abbas 1998, Temina & al. 2005). Our specimen closely matches the modern description of *A. impressula* in Øvstedal & Gremmen (2014).

Acarospora umbilicata Bagl., Mém. R. Accad. Sci. Torino, Ser. 2, 17: 397 (1857) FIG. 2

THALLUS squamulose, convex, 0.4–1.4 mm wide, 0.1–0.3 mm high. Upper surface grey-brown, densely white-pruinose. Epinecral layer 20–25 µm tall. Cortex 22.5 µm thick, with crystals. Algal layer even, 30–112.5 µm thick, algal cells 7.5–17.5 µm in diam. Medulla white, plectenchymatous, scattered to contiguous with crystals in longitudinal sections. APOTHECIA black, disc depression 0.19–1.28 mm. Exciple hyaline, distinct, 25–38 µm wide. Epihymenium brown, 20–30 µm tall. Hymenium hyaline, 37.5–100 µm tall, paraphyses hyaline, simple, apex expanded, conglutinate. Asci 87.5–95 × 20–22.5 µm, 100–200-spored; ascospores simple to 1-septate, 4–5 × 1.5–2 µm, ellipsoid. Subhymenium hyaline, 25–40 µm tall. Hypothecium hyaline, 35–60 µm tall. Algal layer uneven, interrupted by hyphal bundles, contains crystals, ≤100 µm thick, algal cells 7.5–12.5 µm in diam. Medulla containing many crystals, 50–162.5 µm tall.

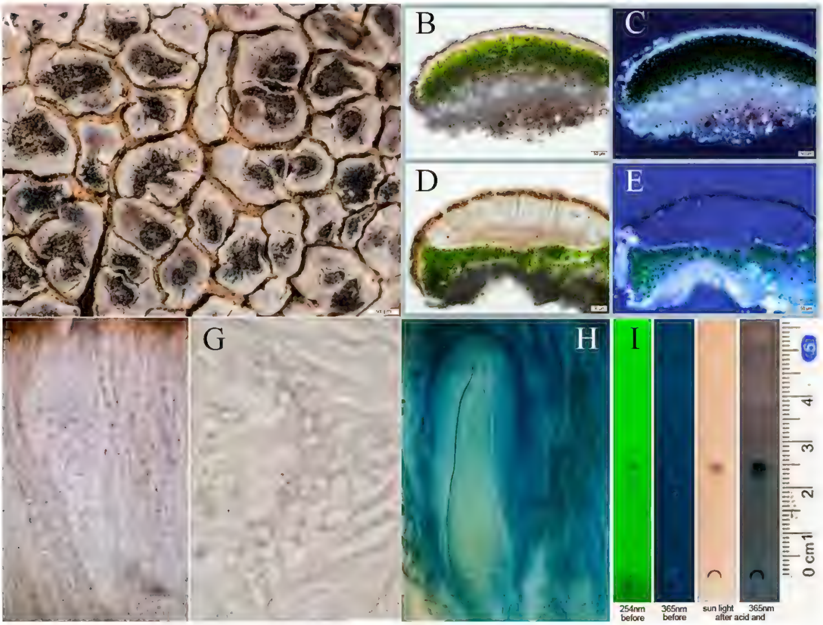

FIG. 2. *Acarospora umbilicata* (Tong 20123044, SDNU). A. Thallus and apothecia; B, C. Thallus section; D, E. Apothecia section; F. Asci; G. Ascospores; H. Asci I+ blue; I. TLC chromatograms.

Chemistry—Thallus K−, C+ red, KC+ red; hymenium I+ blue. Secondary metabolites: gyrophoric acid.

Specimen examined — CHINA. Neimenggu, Ho-lan Mountains, alt. 1500 m, 19 Aug. 2011, D.B. Tong 20123044 (SDNU).

Ecology & distribution—On siliceous rock. Europe, Asia, North Africa, Canary Islands, Madeira Islands (Temina & al. 2005, Galloway 2007). New to China.

Comments—*Acarospora fulva* N.S. Golubk., *A. fuscata* (Nyl.) Th. Fr., *A. glypholecioides* H. Magn., and *A. jenisejensis* H. Magn. are similar to *A. umbilicata* by the C+ red reaction indicating gyrophoric acid as secondary metabolites. However their thalli differ, lacking pruina in *A. fuscata*, colored yellow in *A. fulva*, and wider in *A. glypholecioides* and *A. jenisejensis*. *Acarospora glypholecioides* and *A. jenisejensis* are further distinguished by their shorter ascospores (*A. glypholecioides*, 3–3.5 × 1.7 µm; *A. jenisejensis*, 3–3.5 × 2.5–3 µm; Abbas 1998, Temina & al. 2005, Galloway 2007, Knudsen 2007). Our specimen agrees closely with modern descriptions of *A. umbilicata* (Timdal 1987, Galloway 2007).

Psora decipiens (Hedw.) Hoffm., Descr. Pl. Cl. Crypt. 2: 68 (1794) Fig. 3a–d

Squamules ≤6 mm wide, adnate, scattered to contiguous, concave to convex; upper surface bright red, epruinose or partly to entirely white pruinose, sparingly fissured; margin white, slightly up-turned, soon becoming crenulate; upper cortex ≤150 µm thick, containing crystals of calcium oxalate; medulla, containing calcium oxalate crystals; lower cortex poorly developed or absent. Apothecia ≤2.5 mm diam., marginal, immarginate, black, epruinose. Asci 8-spored, ascospores ellipsoid, simple, hyaline, 10–15 × 6–9 µm. Pycnidia not seen.

Chemistry—Thallus K−, C−, KC−, hymenium I+ blue; no secondary metabolites detected.

Specimen examined: CHINA. Qinghai, Haibeizhan Fengxiakou alpine meadow, alt. 3280 m, 6 Aug. 2007, C. Yuan 20070787 (SDNU).

Ecology & distribution—On soil. Africa, Asia, Australia, Europe, New Zealand, and North and South America (Timdal 2002, Galloway 2007). New to Qinghai Province.

Comments—*Psora decipiens* is characterized by its bright red squamules, marginal apothecia, white margin, and absence of chemical substances. It is closely related to *P. crenata*, which differs by its broader and thicker (10 mm) squamules, usually with a regular central depression, and a down-turned, more or less entire margin. Our specimen is closely similar to modern descriptions of *P. decipiens* (Timdal 1987, Galloway 2007).

Psora gresinonis B. de Lesd., Bull. Soc. Bot. France 77: 614 (1930) FIG. 3E–H

SQUAMULES discrete, attached to the substrate, concave, 2–3 mm wide; upper surface dark brown; margin darker with upper side; upper cortex ≤60 µm thick, lacking calcium oxalate crystals; lower cortex poorly developed. APOTHECIA ≤1.4 mm diam., laminal or submarginal, immarginate, black. ASCI 8-spored, ascospores ellipsoid, simple, hyaline, 10–15 × 7.5–10 µm. PYCNIDIA not seen.

CHEMISTRY—Cortex K–, C–, medulla C–, K+ red, KC+ red; norstictic acid detected by TLC.

SPECIMEN EXAMINED: CHINA. **QINGHAI,** Haibeizhan Fengxiakou alpine meadow. alt. 3250 m, 6 Aug. 2007, Z.S. Sun 20070741 (SDNU).

ECOLOGY & DISTRIBUTION — On soil. Italy, France (Timdal 1984). New to China.

COMMENTS—*Psora gresinonis* is characterized by its dark brown squamules, black margin, and norstictic acid. The species is closely related to *P. vallesiaca* (Schaer.) Timdal and *P. tenuifolia* Timdal, which are distinguished by their reddish brown squamules and white margin (Timdal & Zhurbenko 2004). Our specimen agrees with the original description of *P. gresinonis* by Bouly de Lesdain (1930).

Psora himalayana (C. Bab.) Timdal, Bryologist 89: 262 (1987 ["1986"]) FIG. 3I–L

SQUAMULES ≤4 mm wide, ascending and imbricate; upper surface medium brown or reddish brown to dark brown, epruinose or more rarely faintly white pruinose (especially along the margin); margin white, slightly up-turned, underside brown in center, white near the margin; upper cortex ≤150 µm thick, sometimes containing calcium oxalate crystals; medulla sometimes containing calcium oxalate crystals; lower cortex not sharply delimited from the medulla, containing calcium oxalate crystals. APOTHECIA ≤2 mm diam., laminal, immarginate, black, epruinose. ASCI 8-spored, ascospores ellipsoid, simple, hyaline, 12.5–17 × 5–9 µm. PYCNIDIA not seen.

CHEMISTRY—Thallus K–, C–, KC–, hymenium I+ blue; no substances detected by TLC.

SPECIMEN EXAMINED: CHINA. **QINGHAI,** National Highway 109, Mt. Xiangpi, alt. 3520 m, 15 Aug. 2007, Y.D. Du & X.L. Shi 20071940 (SDNU).

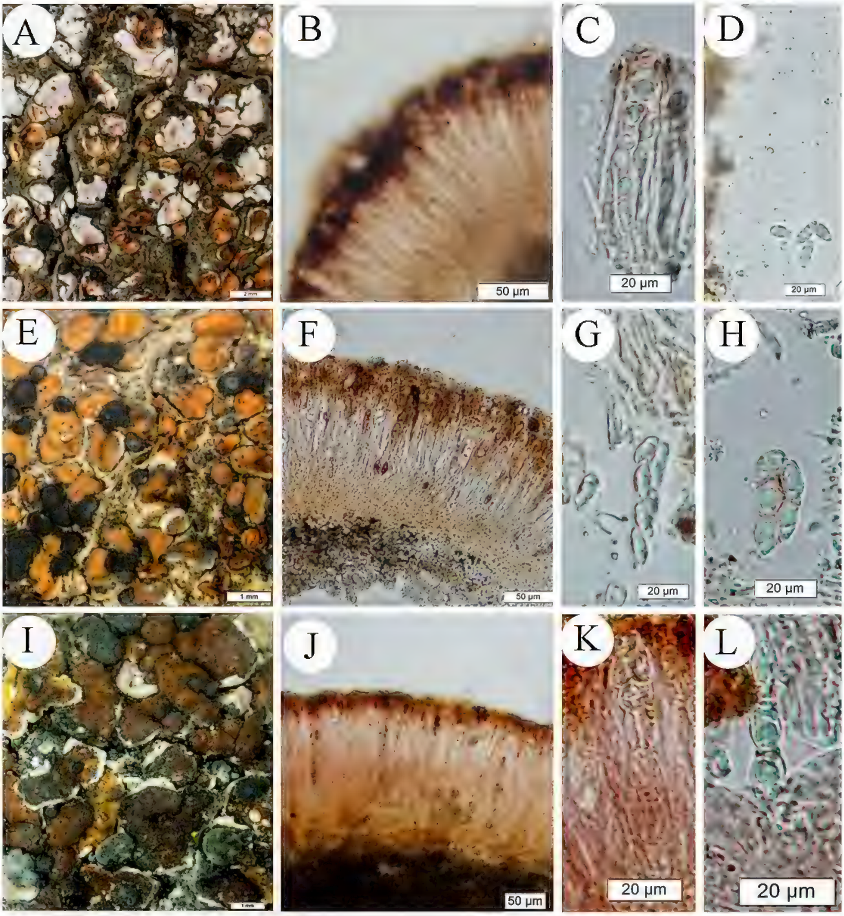

FIG. 3. ***Psora decipiens*** (Yuan 20070787, SDNU). A. Thallus and apothecia; B. Apothecia section; C. Asci; D. Ascospores. ***Psora gresinonis*** (Sun 20070741, SDNU). E. Thallus and apothecia; F. Apothecia section; G. Asci; H. Ascospores. ***Psora himalayana*** (Du & Shi 20071940, SDNU). I. Thallus and apothecia; J. Apothecia section; K. Asci; L. Ascospores.

ECOLOGY & DISTRIBUTION—On soil. Asia, Europe, and western North America (Timdal 2002). New to China.

COMMENTS—*Psora himalayana* is characterized by squamules distinctly white pruinose along the margin and calcium oxalate crystals present in the medulla and/or the lower cortex. The species is closely related to *P. globifera* (Ach.) A. Massal., which differs by its pruina distributed mainly on the upper side near the squamule margins, and its pale to medium brown lower side near the squamule margins (Timdal 1987). *Psora vallesiaca* differs from *P. himalayana* mainly in having norstictic acid (Timdal & al. 2016). Our specimen agrees with the original description of *P. himalayana* by Timdal (1987).

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